WORLD BIOGAS ASSOCIATION

From Waste to Wake: Scaling Bio-LNG for a Net-Zero Maritime Sector

World Biogas Association

- Global association for the biogas, landfill gas and anaerobic digestion (AD) sectors, dedicated to facilitating the adoption of biogas globally.
- Founded in 2016 by associations from the United Kingdom, the United States of America and Italy, together with 20 founding companies.
- It currently represents around 100 organisations, including national associations, from around the world.
- WBA is an accredited member of the UNFCCC and REN21, an official partner of the CCAC (secretariat of the Global Methane Pledge) and the GMI, a founding member of the Global Biofuels Alliance (GBA), and an associate of the Global Bioenergy Partnership.
- WBA works closely with the Global Methane Hub, IEA, UNIDO, FAO, the European Commission and C40 Cities, among others.

Some of WBA members

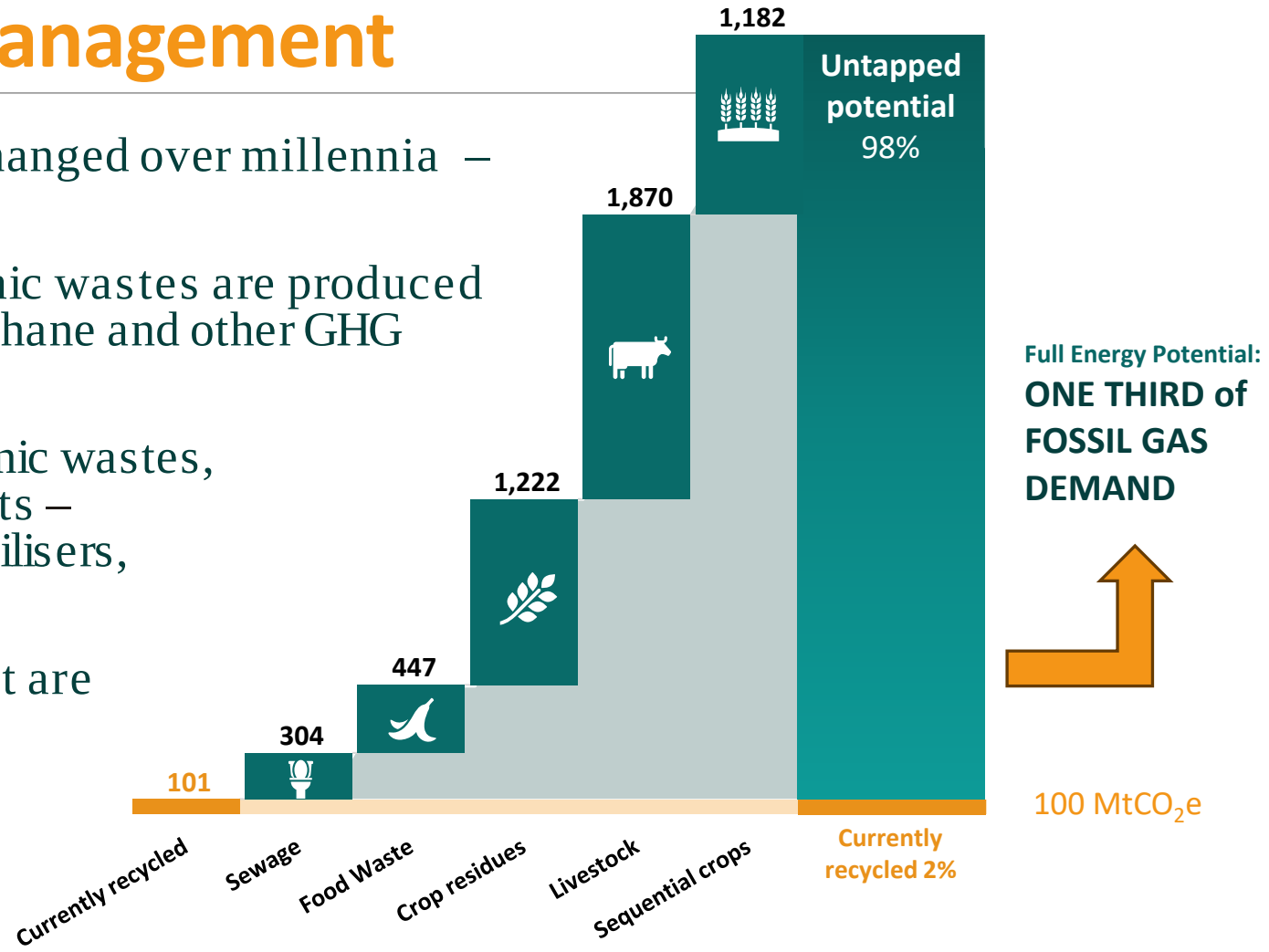
A new era for waste management

Waste management systems haven't changed over millennia – we still either landfill, burn or bury it.

Every year, over 105 billion tons of organic wastes are produced globally, which, if not recycled, emit methane and other GHG emissions – 98% are not recycled.

Anaerobic Digestion (AD) recycles organic wastes, turning a problem into valuable products – biogas/biomethane, bio-CO_2, natural fertilisers, and other useful bio-products.

By recycling those organic wastes that are readily available, it is possible to deliver 50% of the Global Methane Pledge and cut global GHG emissions by 11%.



Global biogas market today

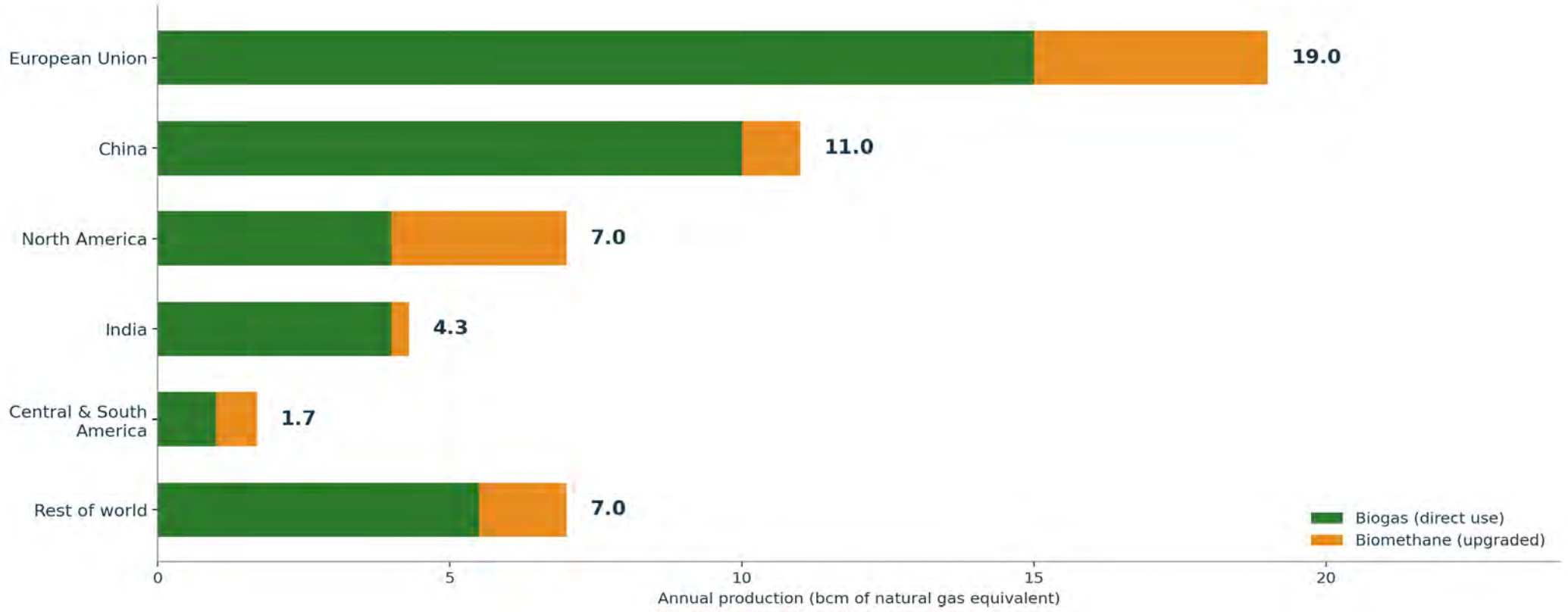
40 billion cubic metres of natural gas equivalent (bcme) of biogas is produced annually (~1% of natural gas demand)

10 bcme of biomethane is produced globally

Investment of USD 2 billion per year

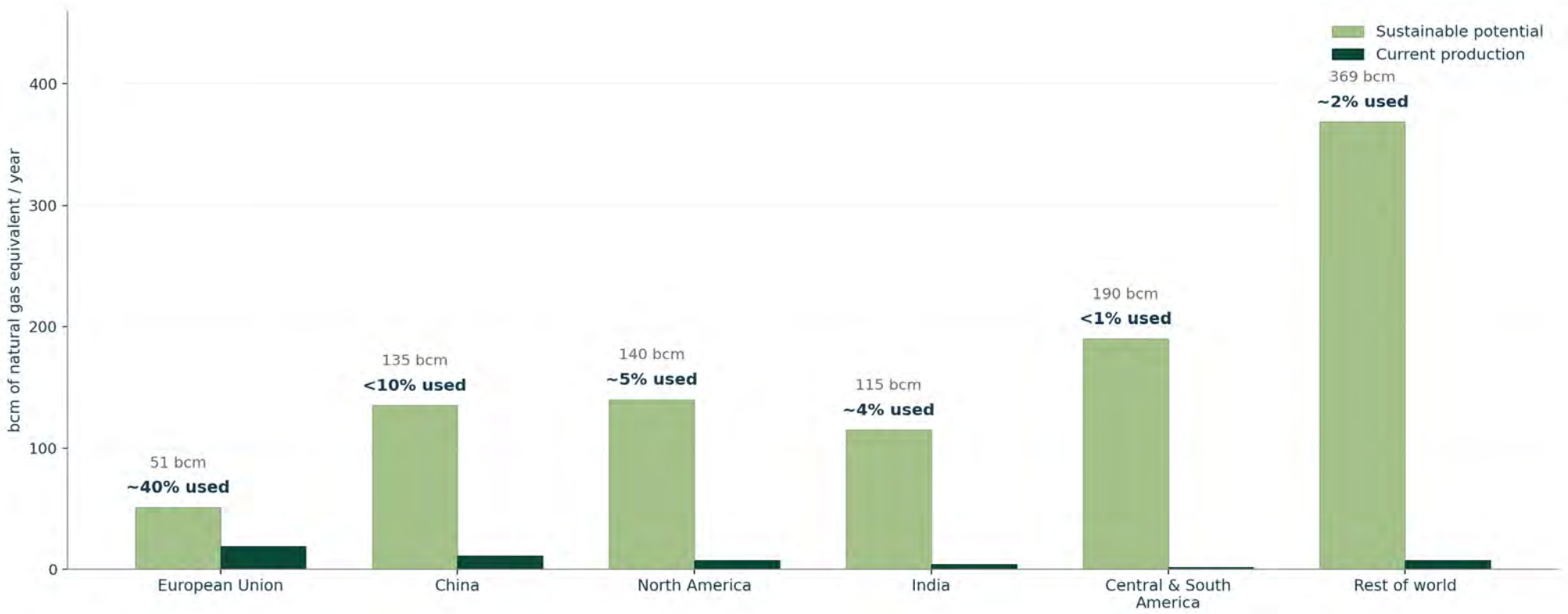
Source: IEA, 2025

Biogas and biomethane production



Source: IEA Outlook for Biogas and Biomethane (2025); 2023 reference year.

Regional Potential vs Production



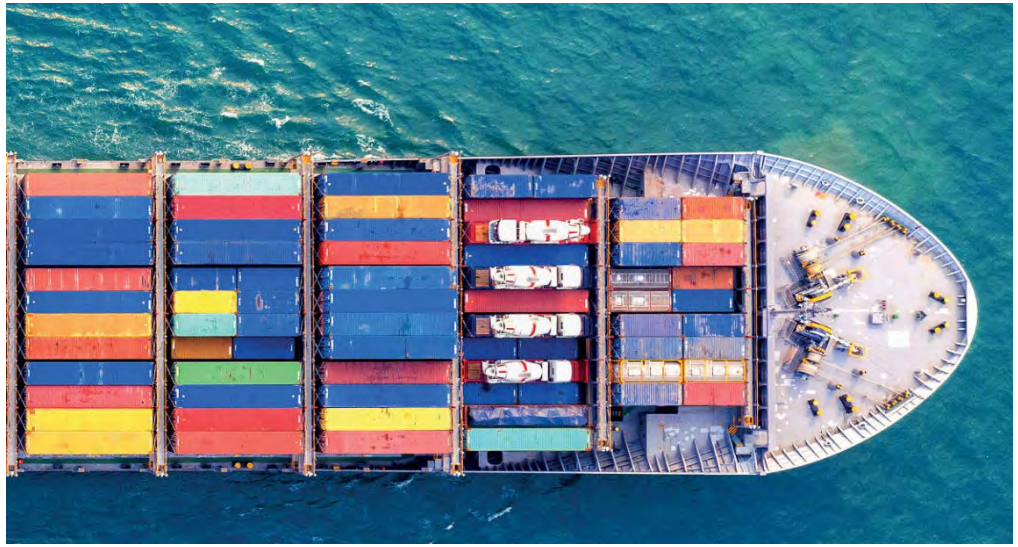
Source: IEA Outlook for Biogas and Biomethane (2025); 2023 reference year for production, 2024 base year for potential.

Global biogas market – looking forward

- Demand for biogas and biomethane projected to double between 2023 and 2035
- Production of biogas and biomethane is expected to increase by 22% by 2030
- Investment expected to hit USD 15 billion annually before 2050
- Emerging markets account for ~80% of global potential for biogases and will dominate growth

Source: IEA, 2025

Biomethane as a Maritime Fuel



- Biomethane can be liquified into Bio-LNG for maritime use
- Bio-LNG is a **practical, scalable and immediate** pathway for some parts of maritime decarbonisation
  - **pure bio-LNG** could meet **3%** of the total energy demand for shipping fuels in **2030** and **13%** in **2050**.
  - **As a drop-in fuel** blended with fossil LNG, bio-LNG could meet **16%** in 2030 and **63% in 2050**, with **a 20% blending ratio**
- Bio-LNG is one of the **lowest cost green fuels**
- When value chains are optimised, bio-LNG can deliver **negative emissions**

Source: SEA-LNG, 2022;
MMMCZCs, Fuel Cost Calculator

The Case for Bio-LNG

Environmental Case

Reduces GHG emissions up to **80%** on a well-to-wake basis compared to conventional marine fuels (LSHFO)

Virtually eliminates SO_x, drastically cuts NO_x, and slashes particulate emissions - delivering air-quality benefits

Produced from waste streams, contributes to **circular economy goals** and abates **methane** emissions

Technical Case

Fully compatible with LNG-ready ships and existing bunkering infrastructure

Can be blended with LNG, enabling gradual decarbonisation without major retrofits

Economic Case

Leverages existing and growing LNG investment & offers competitive cost trajectories relative to e-fuels

Sources of LCA variance

Physical drivers

- **Feedstock:** manure and waste/residue pathways can score low or deeply negative (to below -150 gCO_2eq/MJ) vs fossil LNG +75 to +95. Energy crops vary widely: purpose-grown high-input pathways score positive; marginal land, cover crops, residues score much lower.
- **Plant operations:** methane leakage runs 2-5.5% of output (IEA 2025); internal energy use 15-20% of biogas (upgrading + compression). Closed digestate storage, off-gas combustion, verified leak detection reduce both.
- **End-use engine:** methane slip from combustion can offset upstream gains. IMO default factors 0.15-2.6% across engine types (MEPC.376(80). Orderbook shifting to lower-slip engines; manufacturer R&D in combustion control and methane oxidation catalysts.

Accounting choices

- **Counterfactual:** assessing what would otherwise have happened to the feedstock. Depends on regional baseline practice. E.g., California's LCFS credits avoided methane heavily (US dairy historically used uncovered lagoons), EU RED applies a more conservative credit (European manure management more varied). The same fuel can therefore score very differently.
- **Methane time horizon:** how heavily methane's warming is weighted. GWP100 treats methane as 28× CO_2; GWP20 treats it as 84×.
- **System boundary:** how far the calculation extends. Well-to-tank stops at the fuel; well-to-wake includes combustion (engine slip).

Sources: IEA Outlook for Biogas and Biomethane (2025); IMO LCA Guidelines (MEPC.376(80), 2023); CARB LCFS; EU RED II/III; Concawe LNG well-to-wake (2017); WBA Making Bio-LNG Happen by 2030; DNV Alternative Fuels Insight.

Vessel Segments & Green Corridors

Target Vessel Segments

- **Short-sea shipping & ferries** in EU waters: regular routes, frequent port calls, strong **FuelEU Maritime** incentives
- **Feeder container vessels & coastal bulk carriers** on defined trade lanes near biogas clusters (NW Europe, Scandinavia, SE Asia)
- **Large LNG-powered vessels:** approximately 850 vessels using LNG in operation globally, with around 700 in the orderbook

Rotterdam–Singapore Corridor

- Dedicated **"Methane Track"** successfully piloted mass-balanced bio-LNG bunkering on a large container ship

Baltic / North Sea Corridor

- **Strongest near-term case** for broader Bio-LNG deployment

Bio-LNG Availability Today

- 16 European countries currently produce bio-LNG
- Confirmed production capacity for 2027 adds up to 21.1 TWh per year (**under 1% of global LNG trade — roughly 0.4%)**
- By 2028, a further 153 additional bio-LNG production plants are expected to be built, which would increase production capacity by 13.1 TWh/year
- **80% of bio-LNG** produced in Europe i**s used or planned for road transport**

Source: EBA, 2025

- Offtake possibilities for Bio-LNG are:

Road Transport

Maritime

Industry

Liquefaction to Bio-LNG: Three Pathways

1. Onsite

Pathway: Liquefier at biomethane production site; upgraded biomethane is physically liquefied.

Scale: Small, plant-scale production. Mapped EU fleet ~0.1–0.5 TWh/yr combined.

Best for: Very large rural plants without grid access. Drawback: limited capacity, challenging logistics.

2. Grid gas

Pathway: Biomethane injected into the gas grid; a separate liquefier or terminal recondenser physically produces LNG, with mass balance applied within the relevant gas system.

Scale: Constrained by the specific liquefier or recondenser; e.g. Fluxys recondenser at Zeebrugge ~0.3 TWh/yr long-term (peak ~1.7).

Drawback: More scalable than onsite, but still limited by the physical liquefier's throughput.

3. Equivalence (virtual)

Pathway: Biomethane injected into the gas grid; bio-LNG attributes allocated to LNG at a certified LNG terminal via ISCC-certified mass balance (EU 203-02).

Scale: Based on the host LNG terminal's certified send-out capacity (a certificate-based claim against throughput, not physical bio-LNG output). Tens to hundreds of TWh/yr at a major terminal.

Advantage: Uses existing LNG terminal infrastructure. The only pathway with a credible route to maritime-scale bio-LNG claims, given robust certification and anti-double-counting.

Sources: Fluxys (Leruth, Turin 2026); OIES NG 203 (Olczak 2026); ISCC EU 203-02 Mass Balance Procedure.

Recommendations

Policy Support

- Employ a **technology neutral approach** aimed at driving the lowest cost of compliance
- Establish a **certificate mechanism** to enforce decarbonisation in shipping
- Develop existing certificates into **a single standardised guarantees of origin** for biomethane and alternative fuels
- Recognise **biomethane's GHG savings in regulations**, using a full LCA of its carbon intensity
- Permit **virtual liquefaction pathways**, whereby biomethane tracked with a robust mass balance system through a gas grid can be credibly attributed to sustainable feedstock
- Treat **energy crops as products**, including all cultivation, processing and shipping emissions
- **Recognise negative carbon intensity** values to maximise the credit for Bio-LNG

What is #MakingBiogasHappen?

- #MBH aims to accelerate growth of the global biogas industry by:
  - Addressing fragmented policies and regulations
  - Creating an enabling environment for investment
  - Ensuring growth is safe and sustainable

- Provides tools that can be adapted and adopted by any country/state/city, reducing time required to develop supportive policies, regulations, and standards.
  - Global Biogas Regulatory Framework
  - Anaerobic Digestion Certification Scheme International

Participants of the opening session in the #MakingBiogasHappen programme stakeholder consultation workshop series.

#MakingBiogasHappen - Phase 1

Global Biogas Regulatory Framework

Global Biogas Regulatory Framework

- Provides best-practice policies and regulatory mechanisms that governments and regulators can adopt to ensure the effective use of biogas technologies
- Promotes regulatory harmonisation and investment in the biogas sector

GLOBAL BIOGAS REGULATORY FRAMEWORK

Nine Pillars:

1. International and National Policy
2. Feedstock Policy
3. Biogas Utilisation
4. Digestate Policy
5. Gas Quality Regulations
6. Technical and Operational Quality Standards
7. Permitting Regulations
8. Planning Policy
9. Health, Safety and Environmental Protection

#MakingBiogasHappen - Phase 1

AD Certification Scheme International

AD Certification Scheme International

- Sets minimum health and safety, environmental and operational standards for AD plants.
- Aims to incentivise revenue through maximising operational efficiency.

ADCS INTERNATIONAL

Eleven modules:

1. Site information and understanding
2. Managing health and safety risks
3. Staff training
4. Process monitoring
5. Maintenance of the plant, kit and infrastructure
6. Procuring services
7. Managing environmental risks
8. Cross-contamination regulations compliance
9. Digestate management
10. Biomethane process
11. Life cycle assessment (LCA)

Implementation in Brazil & India

Where we are now:

- **India:**
  - Initiated work with Madhya Pradesh to develop a Biogas Action Plan
  - Exploring partnership with Gujarat State

- **Brazil:**
  - MoUs signed with São Paulo (June 2025) and Paraná (Dec 2025)
  - Refining project methodology and securing funding to enable project start later this year.

Signing of Memorandum of Understanding to implement #MBH phase 2 between WBA and SUPEN, Paraná (top left) and SEMIL, São Paulo (bottom left), and Madhya Pradesh (right).

Thank you

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www.worldbiogasassociation.org/mbh

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